

An Optical Approach to Computation

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Abstract. Using optics in computing systems which refers to as optical computing, is an actively growing field in different areas such as data processing and data transmission. Two different approaches are used in optical data processing to design optical processors. The first approach is to simulate conventional electronic processors by designing optical logic gates. The second approach is to design optical processors, basically different from electronic processors based on physical properties of light, such as high parallel nature, splitting abilities, and high speed of light which may yield to obtain more computational power and efficiency.

In continuous to many other efforts to design optical processors in recent years, we have provided an optical method to solve the 3-satisfiability problem, using existence of several different wavelengths in light rays. We have considered each group of wavelengths as a possible value-assignment for the given 3-satisfiability formula, and we have used optical filters produced in preprocessing phase to drop wavelengths not satisfying the given formula. At the end, existence of some wavelengths in the outgoing light ray indicates that the 3-satisfiability formula is satisfiable. The method constructs polynomial number of optical filters in preprocessing phase taking exponential time. After preprocessing phase, the method requires polynomial time and exponential number of photons to solve each problem instance.

We have also provided an optical method to solve the graph 3-colorability problem. The method starts from some light rays considering each group of them as a possible 3-coloring of the graph, and then drops light rays corresponding to improper colorings using optical filters. Similar to the previous method, the optical filters are created in preprocessing phase in exponential time and the method takes polynomial time and exponential number of photons to solve each problem instance.

Key words: Unconventional Computing, Optical Computing, Optical Data Processing, 3-SAT Problem, Graph Coloring, 3-Colorability

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